ELEC50001 EE2 Circuits and Systems

Problem Sheet 1

(Operation Amplifiers – Lectures 1 – 3)

- Download from the course webpage a copy of MCP601/2/4 operational amplifier datasheet. Based on this data sheet, answer the following questions assuming that VDD = 5V and VSS = 0V.
 - a) This op-amp is modelled using the simplified circuit model shown below. Find the corresponding parameters from the datasheet where appropriate.
 - b) What voltage range at the output?
 - c) You are required to build a voltage amplifier for a signal in the frequency range of 10Hz to 100kHz, what is the maximum gain you can expect to achieve with one of these opamps?
 - d) This op-amp is used as a unity gain buffer amplifier (voltage follower) circuit. The input is driven directly with a 100kHz a digital clock signal between 0V and 3.3V. Sketch the expect output of the buffer amplifier.



2. A truck weighing station incorporates a sensor whose resistance varies linearly with the weight: $R_s=R_0+\alpha W$. Here R_0 is a constant value, α a proportionality factor and W the weight of each truck. R_s is part of an amplifier circuit shown below. Given that $V_{in}=1V$, determine the gain of the system, defined as the change in V_{out} (i.e. δV_{out}) divided by the change in weight W (i.e. δW). You may assume that the op-amp is ideal.



3. Due to a manufacturing error, a parasitic resistance R_P has appeared in the circuit below. Calculate V_{out} in terms of V_1 and V_2 for $A_V = \infty$ and $A_V < \infty$. (Note that R_P can also represent the input impedance of the op-amp). State any other assumptions used.



4. In the non-inverting amplifier shown below, the op-amp offset at its input is represented by a voltage source in series with the inverting input. Calculate Vout.



5. The unity-gain buffer shown below is designed to drive a 100Ω load with an acceptable gain error of 0.5%. Determine the required op-amp open-loop gain Av if the op-amp has an output impedance of $1k\Omega$.



6. The following circuit shows a non-inverting amplifier with a nominal gain of 4 if the op-amp were ideal. Unfortunately the op-amp is perfect except that it has a finite open-loop gain of Av at all frequencies. The specification requires the overall amplifier gain to be within 0.2%.

Given that $R_1+R_2 = 20k\Omega$, determine the minimum value of Av.



7. An inverting amplifier shown below with a gain of -8 with a gain error of ±11% is required. What are the tolerance of the resistors R1 and R2, and what is the minimum open-loop gain of the op-amp required? You may assume that Rout and the input current of the op-amp are negligible. State any other assumption used.

